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Fear of a two-speed monetary union: what does a basic correlation scatter plot tell us?

Jean-Sébastien Pentecôte
CREM-UMR CNRS #6211, University of Rennes 1

Abstract

This paper extends Bayoumi and Eichengreen's (1993) approach to better visualize how far a given country is from a monetary union. Useful information is extracted from the scatter plot of correlation coefficients between supply and demand shocks. Indexes of distance and relative strength of asymmetry are derived from two, linear and nonlinear, combinations of correlations. Using quarterly data on ten countries over 1979-2011, the newly proposed statistical tests are supportive of a two-speed European Monetary Union, despite less asymmetric supply and demand shocks since 1999.

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Contact: Jean-Sébastien Pentecôte - jean-sebastien.pentecote@univ-rennes1.fr.
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1. Introduction

The ongoing marathon for rescuing countries incurring banking and/or sovereign debt crises is threatening cohesion amid the Member States of the European Union. Current worries about a two-speed Europe echoes dramatically with the adjustment problem faced by the European Monetary System following the shock of the German monetary reunification two decades ago. This has led several authors, among which Bayoumi and Eichengreen (1993), to revisit the issue of shock asymmetry in a monetary union (De Haan et al., 2008, for an overview). Loosing exchange rate flexibility as an adjustment tool to macroeconomic disequilibria may be costly according to Mundell's view on optimal currency areas (Dellas and Tavlas, 2009). It will be so in a country subject to specific, rather than common, shocks in the absence of labour mobility and/or wage-price flexibility.

A widely used empirical strategy to tackle this issue consists in estimating the correlation coefficients of the structural shocks between a given country and the monetary union itself. The more correlated shocks are, the less costly should be stabilization policies for the whole union as initially argued by Bayoumi and Eichengreen (*o.p.*). The latter authors explain how to get the series of macroeconomic shocks from the Blanchard and Quah (1989) identification procedure of a two-dimensional vector-autoregressive process. Within the basic aggregate demand-aggregate supply framework, the long-run responses of output and prices allow one to distinguish shocks from the supply side to those from demand in a given country. Computation of correlation coefficients between domestic and foreign shocks of a given type finally leads to a simple scatter plot of the stochastic asymmetry.

The aim of this paper is to show how the information provided by such a box diagram can be synthesised into useful indexes in order to better visualize how far a given country is from a monetary union. The first one gives a direct measure of the distance to the (best) fully symmetric case. That index is derived from two – one linear and the other nonlinear – combinations of the correlation coefficients, depending on the underlying welfare loss function being considered. The second index measures the relative strength of asymmetry in terms of supply and demand shocks. Again, the nonlinear and linear approaches may imply different rankings within a set of countries against the monetary union.

The paper is organized as follows. Section 2 describes how the distance and relative strength indexes can be build from the scatter plot of the correlated supply and demand shocks. Using quarterly data on ten euro and non-euro countries over 1979:I-2011:IV, section 3 gives new empirical evidence on the core-periphery view of EMU given the statistical properties of the distance and the relative strength indexes. Shocks have become more symmetric within but also outside the euro area. Although the relative strength of asymmetry in terms of supply and demand shocks has diminished in the Member States since 1999, new statistical tests are supportive of a two-speed European monetary union.

2. A visual inspection of shock asymmetry through the 'correlation box'

By construction, correlation coefficients between either supply (ρ_s) or demand shocks (ρ_d) take their values in the [-1,1] interval. Graphically, they lie somewhere in the square box delimited by the dashed line as depicted on figure 1 below.

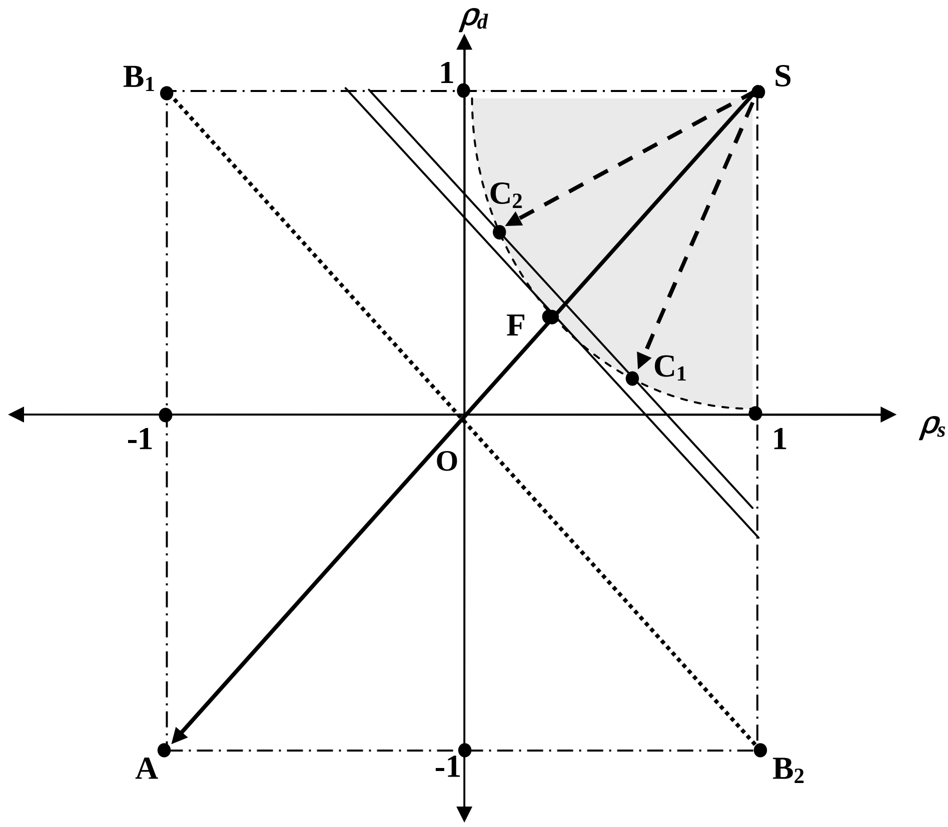


Figure 1: The correlation box and distance to a symmetric monetary union

Point S at the upper right corner corresponds to the fully symmetric case between any candidate member and the reference group (or country) of the single currency area. At the opposite, the lower left point A corresponds to completely asymmetric shocks, in terms of demand as well as in terms of supply. In the core-periphery view of monetary unions popularized by Bayoumi and Eichengreen (1993, 1994), the closer the candidate country to point S is, the lower should be the cost of joining the single currency since adjustments by a common policy should be easier.

It is thus interesting to translate these correlations into a more direct and synthetic measure of distance to EMU. A related issue is the assessment of the relative strength of asymmetries from the demand or the supply sides.

2.1. Distance and welfare loss from shock asymmetry

From the correlation box in figure 1, there are two main ways to compute distance to a perfectly symmetric monetary union. The first one is a standard Euclidean measure which assumes a nonlinear combination of the two pair-wise correlation coefficients, whereas the second one is based on a basic summation of both sources of stochastic asymmetry.

The first approach can be derived from a vector representation inside the correlation box (see Rodgers et al. (1998) for a geometric interpretation of the correlation parameter itself). The resulting index is based on the Euclidean measure of distance separating the candidate country *i*, as illustrated by point C_i on figure 1, from the (best) benchmark case (S) of fully symmetric shocks. The former equals the norm of vector $\overrightarrow{C_i S}$. This quantity is then normalized by the maximum distance from the (worst) completely asymmetric situation (A) relative to the ideal locus S. To sum up, the Euclidean distance index D_E is defined as:

$$D_E^i = \frac{\left\|\overrightarrow{C_i S}\right\|}{\left\|\overrightarrow{AS}\right\|} = \frac{\sqrt{\left(\rho_s^i - 1\right)^2 + \left(\rho_d^i - 1\right)^2}}{2\sqrt{2}} . \quad \textbf{(1)}$$

By construction, the Euclidean distance index lies in the [0,1] range. When D_E is zero, shocks in candidate country *i* are fully synchronized with those in the targeted monetary union. Therefore, both economies will be subject to common (symmetric) shocks only. By contrast, complete asymmetry holds when D_E equals one so that the candidate country is located on point A on figure 1. In that case, economies are hit by purely idiosyncratic demand as well as supply shocks. Over time, country *i* on C_i will be more synchronized with the monetary union if the corresponding distance index decreases.

Such a Euclidean metric of distance can be related to the underlying loss function of the monetary authorities. The former is indeed of the quadratic form. It further assumes that costly asymmetries receive equal weights no matter they originate from the production or the consumption sides. Imperfectly correlated shocks influence the implicit social cost function non-linearly. This implies circular indifference curves, all centered on the best point S. From figure 1 above, this means that any point like C_1 or C_2 on a given indifference curve are associated to the same level of welfare cost. Even though quadratic loss functions are often used to study the behavior of monetary authorities, one may consider an alternative, and more straightforward, index of distance in terms of stochastic asymmetries.

Another way of computing distance to what is commonly viewed as the first best symmetric monetary union (S) consists simply in the summation of the estimated correlations of demand and supply shocks between a given country *i* and the monetary union. Proceeding to normalization, the alternative linear metric of distance D_L is given by the formula:

$$D_L^i = \frac{2 - \left(\rho_s^i + \rho_d^i\right)}{4} . \quad \textbf{(2)}$$

Like the above Euclidean measure, values for the linear distance index lie in the [0,1] range. Furthermore, it is build so as to receive the same interpretation as the D_E metric. For a given country *i*, D_L is nil when its supply and demand shocks are perfectly synchronized to those of the reference country, thereby leading point C_i to match with S on figure 1. At the opposite, the linear distance index takes its maximum value in the event of perfectly negative correlations in terms of both demand and supply disturbances. As before, any decline in D_L means a move towards the symmetric core of the monetary union. Thus, C_i is getting closer to *S* within the above correlation box.

The shape of the indifference curves resulting from formula (2) contrasts sharply with that implied by the Euclidean measure of distance (1). These indifference curves are now illustrated by diagonal lines which are orthogonal to the first secant in the $\left(\rho_s, \rho_d\right)$ space like the one passing through the points C_1 and C_2 on figure 1. According to the core-periphery view, the farther from S that indifference line is, the more costly and the less likely is the adhesion to the monetary union.

There are special circumstances under which the Euclidean and the linear metrics deliver the same values. This is illustrated here by any point on the first secant like *F* where the corresponding diagonal orthogonal to the secant (*AS*) is tangent to the circle centered on *S*. Tangency ensures the equivalence between formulas (1) and (2). However, a country located at *F* will now be viewed as being farther from the symmetric core of the monetary union (*S*) (and its entry more costly) than any country on C_1 (or C_2) because $D_L^F > D_L^{C_1}$. As a result, conclusions may differ in terms of the core-periphery view of the single currency area depending on whether the Euclidean distance D_E or the linear metric D_L is used. It will be even more so if at least one of the two correlation coefficients is reaching one of its bounds, thus placing the country at the border of the correlation box (like B_1 or B_2 on figure 1).

Another interesting case is when two accession countries may exhibit a so-called "reverse asymmetry". This is illustrated by countries 1 and 2 (C_1 and C_2 on figure 1) where $\rho_s^2 = \rho_d^1$ and $\rho_d^2 = \rho_s^1$. Whatever the index used, they are equidistant to the core of the monetary union but $D_L^{1,2} > D_E^{1,2}$. Switching for one index to another will yield a simple rescaling of distance without modifying the core-periphery view of the currency area in terms of welfare.

These comparisons raise an important issue on the welfare consequences of the entry to monetary union. There is indeed no consensus about how the costs from various types of shock asymmetries have to be weighted in the social welfare loss function. At the theoretical level, it remains unclear if shocks from the real supply side as well as from the (nominal and real) demand sector have to be accounted for modeling the cost of joining a monetary union[1].

It remains that the origin of stochastic asymmetry can itself be a matter of concern for monetary unification. One may thus wish to compare the magnitude of shocks correlations.

2.2. The relative strength of shock asymmetry

A second index is constructed under each of the two previous approaches in order to assess the relative intensity of shock asymmetries. According to the trigonometric decomposition underlying the Euclidean distance, the related asymmetry index A_E for country i can be expressed as:

$$A_E^i = \sin\left(\arctan\left(\frac{\rho_d^i}{\rho_s^i}\right) - \arctan\left(\frac{\rho_d^S}{\rho_s^S}\right)\right) = \sin\left(k\pi - \frac{\pi}{4}\right), \quad k \in [-1,1]. \qquad \textbf{(3)}$$

In a fully symmetric monetary union (point S on figure 1), unitary correlations between shocks from the supply and the demand sides imply $\arctan\left(\frac{\rho_d^S}{\rho_s^S}\right) = \frac{\pi}{4}$. Thus, a given country i can belong to one of the three following cases:

a) First, it can be located somewhere below the 45° line [AS] in the correlation box like point C_1 in the above figure 1. This signals greater asymmetry from the demand side than from the supply side. Since ρ_d is lower than ρ_s', A_E takes negative values in the [-1,0[range.
b) Second, it can be situated somewhere above [AS] like point C_2. Country i will thus exhibit stronger asymmetry in terms of supply than in terms of demand (relative to the monetary union itself). The asymmetry index A_E will be positive in the]0,1] interval.

[1] Nolan (2002) argues that only shocks to real output really matter for comparing the incurred welfare losses under alternative monetary regimes. By contrast, Lane (2000) finds that the choice of the exchange rate regime when economies are subject to purely asymmetric demand shocks than when they are hit by productivity shocks. These views are however challenged by Roisland and Torvik (2003) who show that greater asymmetry in production may be an additional incentive for one country to enter the monetary union.

c) Third and finally, there may be exactly the same level of asymmetry in terms of demand and supply shocks, thus implying $A_E = 0$ everywhere on the segment [AS].

Given the correlation box, the A_E index is build in order to have the three following properties[2]:

- it is nil on the diagonal line [AS] since supply and demand shocks are equally correlated which corresponds here to the benchmark case;
- in absolute terms, A_E increases as the country moves away from [AS] and decreases as it goes closer to that benchmark diagonal line;
- it takes extreme values when the two correlation coefficients are of the same magnitude but of opposite signs such that A_E=1 on]OB_1] and A_E=-1 on]OB_2].

As before, let us assume that country 1 is situated on C_1 while country 2 lies on C_2. They are indeed at equal distance to the fully symmetric monetary union according to index D_E but they exhibit contrasting patterns in terms of shock asymmetry as revealed by index A_E. Heterogeneity arises mostly from the supply side in country 1, while specific demand shocks dominate in country 2. As shown on figure 1, the two new indices based on shock correlations can be used to identify countries belonging to the core or to the periphery of a fully symmetric monetary union.

This calls for some words of caution about the exact meaning of the index of relative strength of asymmetry A_E. What matters is the angle made by the vector starting from the origin O and ending at C_i for a given country *i* with respect to the vector $\overrightarrow{OS}$ ($\overrightarrow{OA}$ resp.) above (below resp.) [B_1B_2]. It follows that two countries will have the same value for A_E if they are belonging to the same semi-diagonal starting from O perpendicular to [AS]. From this logic, A_E^F equals A_E^S on figure 1.

Alternatively, one may consider a measure of the relative discrepancy of shock asymmetry through a linear combination the correlation coefficients in terms of supply and demand. Formally, this gives rise to the new index for any country *i:*

$$A_L^i = \frac{\rho_d^i - \rho_s^i}{2}. \tag{4}$$

A_L is intended to fulfil the first two properties of its A_E alternative. Thus, it equals zero when the candidate country exhibit the same size of stochastic asymmetry from the supply and the demand sides, *ie* along the diagonal [AS] on figure 1. Index A_L is strictly positive for any point above [AS] like C_1 on figure 1, while it is negative for any locus below that line like C_2.

There may be significant departures of the A_L index from its A_E counterpart. According to equation (4), all countries on a given segment parallel to [AS] are now characterized by the same value for A_L. Instead, these will differ markedly by their A_E metric. Intuitively, the absolute value of A_L is higher, the further is the representative point C_i away from the diagonal [AS], that is away from points A and S simultaneously. The maximum value of the A_L index is unity when the country is located on the upper left corner of the correlation box (B_1), while it reaches its minimum of minus one when located on the bottom right corner on figure 1 (B_2). As regards the A_E index, it is maximum (minimum respectively) on the whole segment]OB_1] (]OB_2] respectively).

[2] Notice that $sin(arctan(x)) = \frac{x}{\sqrt{1+x^2}}$.

3. Is there still a two-speed euro area?

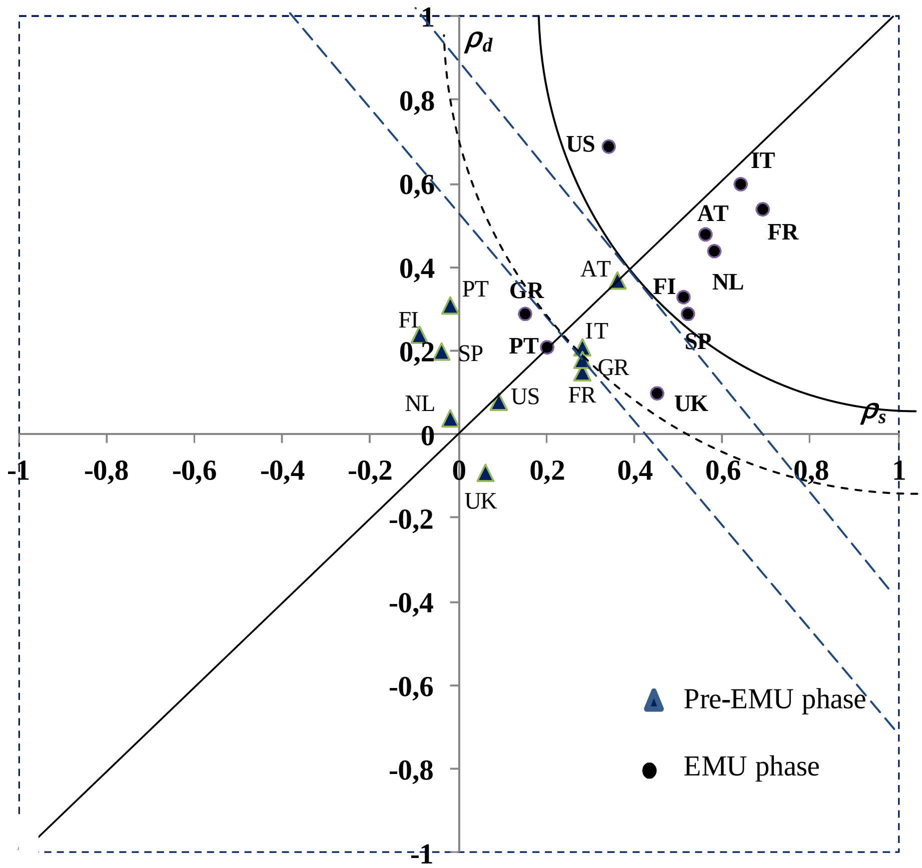
The following section discusses the usefulness of these new indexes in the wake of the process to European monetary unification (EMU). The dataset is made of quarterly observations of the consumer price and the gross domestic product indexes (base 100=2005) over 1979:I-2011:IV This coincides with the launch of the Exchange Rate Mechanism as the interim monetary regime before EMU. I consider seven founder member countries of the euro area (Austria, Finland, France, Italy, Netherlands, Portugal, and Spain) together with Greece and two major non-euro countries, namely the UK and the USA for comparison purposes. Seasonally adjusted data come from Eurostat, except Greece for which OECD data are used.

In line with Bayoumi and Eichengreen (1993), the structural vector autoregression (SVAR) approach is applied in four steps: first, a first-order log-difference VAR(1) is fitted for each country with Germany taken as the reference country for the EMU; second, the identification of supply and demand shocks is achieved through Blanchard and Quah's (1989) decomposition, assuming long-run neutrality of demand shocks on output; third, the correlation coefficients of shocks are computed; fourth and finally, the estimated correlations allow to build the indexes of distance and of relative strength of stochastic asymmetries presented in the previous section. Two sub-periods are distinguished: the pre-EMU phase ends in 1998:IV (just before the launch of the euro), while the EMU phase prevails thereafter.

First of all, it is useful to have a look at the estimated shock asymmetry in the correlation box as given in figure 2 below.

Like the previous studies, raw estimated correlation coefficients are reported here[3]. The pre-EMU phase is characterized by two distinct groups of countries in terms of shock comovements. On one hand, Austria, France, and Italy show the highest correlations of demand shocks with respect to the German ones. Austria is the only country lying almost on the 45° line (passing through A and S as in figure 1), while synchronization in terms of demand shocks is pretty much lower in the French and Italian cases. Like these two countries, Greece also belongs to the less distant group to Germany in terms of shock asymmetry. On the other hand, aggregate disturbances in the remaining European countries are less synchronized with their German counterpart than those hitting the United States before the euro. This supports the core-periphery view of EMU as in Bayoumi and Eichengreen (1993).

[3] As discussed by Zimmermann et al. (2003), bias in the first-order moment has hump-shaped pattern and is maximal when $\rho_{s,d} = 1/\sqrt{3}$. However, it can be neglected here given the quite large samples at hand.



Note: AT: Austria, FI: Finland, FR: France, GR: Greece; IT: Italy, NL: Netherlands, PT: Portugal, SP: Spain, UK: United Kingdom, US: United States.

Figure 2. Empirical evidence of shock asymmetry with respect to Germany

Turning now to the EMU phase, a striking feature is the general movement towards the upper right corner of the correlation box, thus meaning a noticeable move towards more symmetric demand as well as supply shocks with respect to Germany. The previous group of core countries is joined by the Netherlands. Shocks are, by far, more correlated than before EMU in Finland and Spain. By contrast, signs of improvement are more modest in Portugal than in the United Kingdom or even in the US. Unlike the euro Member States, the two latter countries exhibit the strongest but diametrically opposed departures to the 45-degree line. With the noticeable exception of Greece, there is some convincing evidence of convergence of the EMU countries to a more homogeneous set of countries. It remains however that shock asymmetry has not completely disappeared since all the point estimates of correlation coefficients are below 0.7.

Next, I compute the indexes of distance and those of relative strength of stochastic asymmetry. Full results are reported on table 1 below. Point estimates of the linear and nonlinear distance indexes imply very contrasting country rankings during the pre-EMU period, while these differences have almost vanished since EMU. A similar pattern is observed in the relative strength of supply and demand asymmetries.

Table I. Correlation of shocks from structural VARS and distance to full symmetry.

	Period	Euro-members								Non-euro members	
		AT	FI	FR	GR	IT	NL	PT	SP	UK	US
Correlation of Supply Shocks ρ_s	Pre-EMU	0.36	-0.09[a]	0.28	0.28	0.28	-0.02[a]	-0.02[a]	-0.04[a]	0.06[a]	0.09[a]
	EMU	**0.56[b]**	**0.52**	**0.69**	**0.15[a,b]**	**0.64[b]**	**0.58**	**0.20[a,b]**	**0.51**	**0.45[b]**	**0.34[b]**
Correlation of Demand Shocks ρ_d	Pre-EMU	0.37	0.24	0.15[a]	0.21[a]	0.18[a]	0.04[a]	0.31	0.20[a]	-0.09[a]	0.08[a]
	EMU	**0.48[b]**	**0.29[b]**	**0.54[b]**	**0.29[b]**	**0.60[b]**	**0.44[b]**	**0.21[a,b]**	**0.33[b]**	**0.10[a,b]**	**0.69**
Euclidean Distance D_E	Pre-EMU	0.32	0.47	0.39	0.38	0.39	0.49	0.44	0.47	0.51	0.46
	EMU	**0.24**	**0.30**	**0.20**	0.39	**0.19**	**0.25**	**0.40**	**0.29**	**0.37**	**0.26**
Linear Distance D_L	Pre-EMU	0.32	0.46	0.39	0.38	0.39	0.49	0.43	0.46	0.51	0.46
	EMU	**0.24[c]**	**0.30**	**0.19**	**0.39[c]**	**0.19**	**0.24**	**0.40[c]**	**0.29**	**0.36**	**0.24**
Relative Asymmetry A_E	Pre-EMU	0.02	-0.91	-0.27	-0.14	-0.20	-0.93	-0.75	-0.84	-0.98	-0.01
	EMU	**-0.07**	**-0.28**	**-0.12**	**0.31**	**-0.03**	**-0.14**	**0.02**	**-0.20**	**-0.53**	**0.33**
Relative Asymmetry A_L	Pre-EMU	0.01[d]	0.17	-0.06	-0.03	-0.05[d]	0.03[d]	0.17	0.12[d]	-0.08[d]	-8e-4[d]
	EMU	**-0.04[d,e]**	**-0.12[d]**	**-0.07[d,e]**	**0.07[d,e]**	**-0.02[d,e]**	**-0.07[d,e]**	**0.01[d,e]**	**-0.09[d,e]**	**-0.18[d,e]**	**0.18[d,e]**

Notes: EMU starts from 1999:I and ends either in 2011:IV or in 2010:IV depending on data availability. Letters behind figures indicate *non-rejection* from the statistical tests at the 5% level of risk with successive null hypotheses: [a] $\rho_{s,d}$=0 during pre-EMU or EMU, [b] $\rho_{s,d}^{Pre-EMU} = \rho_{s,d}^{EMU}$, [c] $D_{E,L}^{Pre-EMU} = D_{E,L}^{EMU}$, [d] A_L=0 during pre-EMU or EMU, [e] $A_L^{Pre-EMU} = A_L^{EMU}$(10% level of risk). Country codes: AT: Austria; FI: Finland; FR: France; GR: Greece; IT: Italy; NL: Netherlands; PT: Portugal; SP: Spain; UK: United Kingdom; US: United States.

One may also be interested in the statistical properties of D_E and A_E like those of D_L and A_L. To this end, let Z_s and Z_d be the respective Fisher's Z transformations of parameters ρ_s and ρ_d, as given by the general formula:

$$Z_k = \frac{1}{2}\ln\left(\frac{1+\rho_k}{1-\rho_k}\right). \quad \textbf{(5)}$$

The Z statistics are asymptotically normally distributed with mean zero and variance equal to $\frac{1}{T-3}$ given the sample size T (disregarding potential bias in the variance as stressed by Zimmerman et al., 2003). Assuming independence between these two correlation coefficients for a given country (as assumed from the identification step of the vector autoregression), the test statistics (Z_d+Z_s) and (Z_d–Z_s) are also white Gaussian random variables with variance $\frac{2}{T-3}$.

The statistical distributions of the indexes of distance like those of relative asymmetry are not obvious. However a test for equal symmetry of supply and demand shocks ($A_{E\ or\ L}$=0) amounts to test for $\rho_d^{C_i} - \rho_s^{C_i} = 0$. This can be seen from equation (3) (rearranged according to footnote 1) and equation (4) in the previous section. From what precedes, Fisher's Z transformation (5) is diverging when shocks tend to be perfectly correlated, thus preventing from a formal test for zero distance to fully symmetry.

Knowing this, five statistical tests have been performed so as to check for the following null hypotheses: *a)* a zero coefficient of correlation between shocks under each sub-period; *b)* unchanged shock asymmetry before and after EMU; *c)* no change in distance following the switch to EMU in 1999; *d)* shock asymmetry of equal size from both the supply and the demand sides; *e)* no change in the relative size of shock asymmetry since 1999.

As summarized in table 1 above, the first test confirms the visual inspection from the correlation box in figure 2. Two groups of countries now emerge clearly in terms of correlation between supply shocks before EMU: it is positive and statistically significant in Austria, France, Greece, and Italy only. Like Bayoumi and Eichengreen (1993), there is a less clear-cut distinction between the core and the periphery in Europe from the demand side. Furthermore, rejections of the null of non-correlated shocks are becoming seldom during the EMU period. However, this is observed for euro as well as for non-euro economies. It is thus difficult to relate these findings to a specific euro effect.

As revealed by the second battery of tests, changes in shock correlation, if any, have resulted in weaker asymmetry under EMU than before. The evidence is mixed since major changes concern mostly supply shocks, whereas there are rarely significant in terms of demand (except in the USA, and in Italy at the 10% level).

Given the third type of test, distance to Germany in terms of shocks comovements has improved significantly in most of the countries under study since EMU. Exceptions are Austria, Greece, and Portugal. Again, convergence to full symmetry is not specific to the euro area since deeper synchronization of macroeconomic shocks seems to have occurred in non-euro countries too, as shown in table 1 above.

Likewise, tests for a substantial gap between correlation coefficients in terms of supply and demand are subject to few rejections of the null. Significant departures of the A_L index from zero are observed in Finland, France, Greece, and Portugal during the pre-EMU period. This holds true only in Greece (and the US) thereafter. This is an additional piece of evidence of greater homogeneity in terms of shocks within EMU, disregarding the Greek case.

The latter conclusion is somewhat tempered by the final battery of tests. There are very few rejections of a change in the relative strength of asymmetry. These concern Finland and Netherlands when the risk level of type-I errors is raised at 10%.

4. Conclusion

This paper has shown how useful information can be extracted from the scatter plot of correlation coefficients between macroeconomic shocks arising from Bayoumi and Eichengreen's (1993) empirical approach. In particular, assessing distance to the first-best symmetric monetary union and the relative strength of asymmetries crucially depends on the underlying way of modeling the welfare loss function. As concerns the European experience during 1979:I-2011:IV, estimates show that discrepancies between the linear and the non-linear decompositions of shock correlations have tended to vanish since the euro. However, statistical inference is easier to implement if it is based on a linear combination of the correlation coefficients than using a trigonometric approach. All in all, the new tests proposed here support the idea of a two-speed Europe even since EMU.

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